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Abstract

DEVELOPMENTS IN FUEL FABRICATION FOR RESEARCH REACTORS IN BRASIL

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The authors describe the experimental development studies carried out for the fabrication of fuel elements for the Argonaut reactor of the Instituto de Engenharia Nuclear, Rio de Janeiro,Gb and for the Re-Suco, a sub-critical assembly loaded with 40,1 mm UO_2 pellets, of the Instituto de Energia Atômica.

In both developments, the selection of the fabrication procedure has been established to utilize equipment which could be built under short notice by local manufacturers.

Before the actual fabrication of the fuel plates for the Argonaut reactor was started, extensive experimental studies with cermets of 50 % U_3O_8 of natural isotope content and 50 % aluminum powder were conducted. Utilizing U_3O_8 powder of the same grain size of that of the 20 % enriched oxide, the essential variables of the fabrication process could be properly determined. After study of the cast cladding process, the procedure was evolved to roll bonding of picture frame sets comprising the cermet, which has been previously sintered under argon. Two complete mock-up fuel elements with natural uranium were built to check the reproducibility of the results before the production of the actual fuel plates was started.

The picture frame sets were designed to provide complete cladding, including the ends of the plates, to the finally deformed thin core. Each fuel element comprises 17 plates, 2,5 mm thick, 72,5 mm wide and 610 mm long, with face cladding of 0,35 mm thick. Each plate contains 19,3 g of U-235. Experimental work consisted mainly of: charge preparation; compacting under variable pressures in dies of different geometries; presintering of the compacts under argon; assembly of the picture frame components; hot-rolling of the assembled welded sets, and the final cold rolling operations to meet the dimensional and physical specifications of the fuel plates.

The Re-suco sub-critical assembly contains 313 fuel elements, 1100 aluminum alloy tubes of 44 mm outside diameter, 40,5 mm inside diameter, 1309 mm total lenght, each of them with 50 pellets of 40,1 mm diameter and weighing 152 g. The total load requires 15.650 pellets weighing 2.379 kg.

Nuclear grade ammonium diuranate, produced at the IEA, was the starting material for the pellet fabrication. The fabrication process was thoroughly investigated in view of minimizing the operating costs. Through acurate control of the calcining, reduction and conditioning steps, a charge of high compactability has been obtained, which allows the pellet production with the required density of $6,8 \pm 0,2$ g/cm^3 under compacting pressure of only 1,2 t/cm^2; these pellets are further sintered under argon at a fast rate in a eight-zone, electrically heated, continuous sintering furnace. The reproducibility of the dimensions and density of the sintered pellets has found to be excellent.